6 Ansal is investigating the wingspans of Monarch butterflies in two different regions, X and Y. He takes a random sample of 8 Monarch butterflies from region X and records their wingspans, x cm. His results are as follows.

8.2 7.0 7.3 8.8 7.8 8.5 9.2 7.4

Ansal also takes a random sample of 9 Monarch butterflies from region Y and records their wingspans, y cm. His results are summarised as follows.

$$\Sigma y = 71.10 \qquad \Sigma y^2 = 567.13$$

Ansal suspects that the mean wingspan of Monarch butterflies from region X is greater than the mean wingspan of Monarch butterflies from region Y. It is known that the wingspans of Monarch butterflies in regions X and Y are normally distributed with equal population variances.

Test, at the 10% significance level, whether Ansal's suspicion is supported by the data. [8]

1 Farmer A grows apples of a certain variety. Each tree produces 14.8 kg of apples, on average, per year. Farmer B grows apples of the same variety and claims that his apple trees produce a higher mass of apples per year than Farmer A's trees. The masses of apples from Farmer B's trees may be assumed to be normally distributed.

A random sample of 10 trees from Farmer B is chosen. The masses, x kg, of apples produced in a year are summarised as follows.

$$\Sigma x = 152.0 \qquad \Sigma x^2 = 2313.0$$

Test, at the 5% significance level, whether Farmer B's claim is justified. [6]

2 Shane is studying the lengths of the tails of male red kangaroos. He takes a random sample of 14 male red kangaroos and measures the length of the tail, xm, for each kangaroo. He then calculates a 90% confidence interval for the population mean tail length, μm, of male red kangaroos. He assumes that the tail lengths are normally distributed and finds that $1.11 \leqslant \mu \leqslant 1.14$.

Find the values of Σx and Σx^2 for this sample. [6]

4 Manet has developed a new training course to help athletes improve their time taken to run 800 m. Manet claims that his course will decrease an athlete's time by more than 2 s on average. For a random sample of 10 athletes the times taken, in seconds, before and after the course are given in the following table.

Athlete	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Before	150	146	131	135	126	142	130	129	137	134
After	145	138	129	135	122	135	132	128	127	137

Use a *t*-test, at the 5% significance level, to test whether Manet's claim is justified, stating any assumption that you make. [8]

3 The heights, x m, of a random sample of 50 adult males from country A were recorded. The heights, y m, of a random sample of 40 adult males from country B were also recorded. The results are summarised as follows.

$$\Sigma x = 89.0 \qquad \Sigma x^2 = 159.4 \qquad \Sigma y = 67.2 \qquad \Sigma y^2 = 113.1$$

Find a 95% confidence interval for the difference between the mean heights of adult males from country A and adult males from country B. [8]

1 Ellie is investigating the heights of two types of beech tree, A and B, in a certain region. She has chosen a random sample of 60 beech trees of type A in the region, recorded their heights, x m, and calculated unbiased estimates for the population mean and population variance as 35.6 m and 4.95 m^2 respectively.

Ellie also chooses a random sample of 50 beech trees of type B in the region and records their heights, y m. Her results are summarised as follows.

$$\Sigma y = 1654 \qquad \Sigma y^2 = 54\,850$$

Find a 95% confidence interval for the difference between the population mean heights of type A and type B beech trees in the region. [6]